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Temperature - Initiation factor of Red Tide Bloom in the Kastela Bay (Adriatic Sea, Yugoslavia)

Ivona MARASOVIC

Institute of Oceanography and Fisheries, 58000 Split, P.O. Box 114 (Yugoslavia)

Year-to-year recurrence of red tides by the Gonyaulax polyedra in the same area (eastern part of the Kaštela Bay) led us to suspect that cysts or "seed population" were involved. The fact that sea water samples from this area very often contain resting cysts of G.polyedra supports this hypothesis to a certain extent. Vegetative cells are typically present from April to November but not observed during the winter season when a massive diatom bloom often occurs. During April, and thereafter, dinoflagellates become more and more important within the phytoplankton community. During July, a monospecific bloom of G. polyedra extending through August and September vary in intensity over short time scales. In order to study mechanism initiating and supporting red tide occurrences in the Kaštela Bay a monitoring was undertaken during the summer 1988 and 1989. All standard oceanogrphic parameters (T, Sx10^{-3}, O_2, pH, transparency, nutrients, density of phytoplankton cells) were sampled on a weekly basis.

The analysis of temperature data pointed to the fact that red tide bloom in the Kaštela Bay is always associated with the increased sea water temperature exceeding 20°C. When surface temperature attains 20°C the bloom begins to develop reaching its peak intensity not earlier than when bottom layers attain the same temperature. The bloom persists until the surface temperature drops below 20°C (Table 1).

Table 1. Sea water temperature, existence of G.polyedra red tide and number of G. polyedra cells in the eastern part of the Kaštela Bay

Period		T(°C)	Existences of R.T. + or -	N_o of G. polyedra cells
July,	1983.	23,3	+	1,0 x 10^6
June,	1984.	21,2	+	1,2 x 10^6
July,	1984.	23,2	+	1,0 x 10^7
August,	1984.	22,1	+	1,1 x 10^7
May,	1985.	19,2	-	9,2 x 10^4
June,	1986.	20,7	+	1,3 x 10^6
April,	1988.	15,9	-	0
June,	1988.	24,1	+	3,5 x 10^6
July,	1988.	26,0	+	3,8 x 10^6
August,	1988.	26,9	+	4,0 x 10^6
September,	1988.	23,7	+	3,2 x 10^7
June,	1989.	19,7	-	6,0 x 10^4
July,	1989.	23.9	+	4,3 x 10^7

Even though the bloom of G.polyedra takes place in the surface layer, temperature of the bottom layer is also of importance for its development, that is the temperature which makes possible the excystment of G.polyedra. As shown by our results, temperature at which the excystment of G.polyedra starts at about 20°C. Upon excystment, vegetative cells of G. polyedra swim actively to the sea surface concentrating in large quantities. Red tide bloom terminates with the cooling of surface layer (temperature drops below 20°C). This is due to the fact that the bloom is limited to the surface layer since G.polyedra is markedly photophylous requiring high light intensity (ANDERSON et al., 1987).

Red tide spreading all over the bay (during September, 1988 and July, 1989) may also be related to the heating of deeper layers. Data on temperatures in summer 1988 and 1989 point to the fact that spreading of red tide all over the bay came as a consequence of thermocline descending between 10 and 20 m depth (Table 2). At that time the bottom layer of a large part of the bay attained 20°C temperature causing thus the excystment of a large number of G.polyedra cells.

Table 2. Sea water temperature (°C) in the deepest part of the Kaštela Bay during the period of investigation (1988 and 1989)

Depth(m)	V	VI	VII	VIII	IX	X
0	20,00	22,68	24,20	26,20	23,21	-
5	18,02	19,02	24,20	21,38	22,98	-
10 1988	15,32	18,40	17,32	19,04	22,00	-
20	14,70	17,12	15,30	15,54	16,49	-
35	13,99	14,90	14,18	14,06	14,78	-
0	14,69	19,60	24,64	22,23	-	16,80
5	14,70	18,80	24,56	22,18	19,85	16,80
10 1989	14,65	18,24	21,10	21,87	19,60	16,83
20	14,50	16,60	17,38	18,66	18,90	17,41
35	14,28	15,62	14,94	14,60	17,19	16,60

Our analyses indicate that the temperature determines initiation and termination of G.polyedra blooms in the Kaštela Bay. The limiting temperature is found to be around 20°C.

REFERENCES

ANDERSON,D.M., C.D. TAYLOR and E.V.ARMBURST, 1987. The effects of darkness and anaerobiosis on dinoflagellate cyst germination. Limnol. Oceanogr., 32(2): 340-351.